Tutorial #11

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Introduction to Data Communications

1. Obtain the Channel Capacity in bit rate, on a 2500 Hz carrier, if the signal to noise ratio (SNR)dB = 20 dB.

Solution:

Given,

(SNR) dB = 20dB

Using the formula,

(SNR) dB = 10 * $\log_{10}$ (signal power/noise power)

Therefore,

20dB = 10 * $\log_{10}$ (snr)

log10 (snr) = 20/10

= 2

snr = 10^2

= 100

Using Shannon's Law,

C = B * $\log_2$ [1 + snr]

C = 2500 * $\log_2$ (1 + 100)

C = 2500 * log2 (101) ***; $\log_2$ (101) =*** $\frac{\log_{10}(101)}{\log_{10}(2)}$

= 2500 * 6.66

C = 16.65 Kbps

2. Obtain the CRC for the data stream 0100 0011 ('C') using pattern 1011 using the shifted polynomial method.

Solution:

(Data polynomial form * highest power of CRC (=x^3))

a) First shift the input data by 3 bits to make room for 3 CRC bits (the CRC pattern 1011, has 4 bits hence CRC is 4-1 = 3 bits)

(Another way of looking highest power in CRC pattern is x^3 - hence CRC has 3 bits)

Data 0 1 0 0 0 0 1 1

Shifted data (by 3) 0 1 0 0 0 1 1 0 0 0

|----|

CRC bits init to 0

Shifted data D(x) = $x^9 + x^4 + x^3$

**** ***a simple method, when they are more experienced, shift left by 3 = multiply by x^3***

Shifted D'(x) = $(x^6 + x + 1)*x^3 = x^9 + x^4 + x^3$

b) then calculate CRC for the shifted data polynomial

$$
\begin{array}{r}
x^6 + x^4 + x^3 + x^2 + x \\
\hline
x^3 + x + 1 \;|\; x^9 + x^4 + x^3 \\
x^9 + x^7 + x^6 \\
\hline
x^7 + x^6 + x^4 + x^3 \\
x^7 + x^5 + x^4 \\
\hline
x^6 + x^5 + x^3 \\
x^6 + x^4 + x^3 \\
\hline
x^5 + x^4 \\
x^5 + x^3 + x^2 \\
\hline
x^4 + x^3 + x^2 \\
x^4 + x^2 + x \\
\hline
x^3 + x \\
x^3 + x + 1 \\
\hline
1
\end{array}
$$

CRC (x) = 1

=> CRC bits = 0 0 1 (3-bit CRC)

c) Then insert the CRC in the CRC bits created by the shift (a)

Sent message bits:

Initially:

Shifted data (by 3) 0 1 0 0 0 0 1 1 0 0 0
|----|
CRC bits init to 0

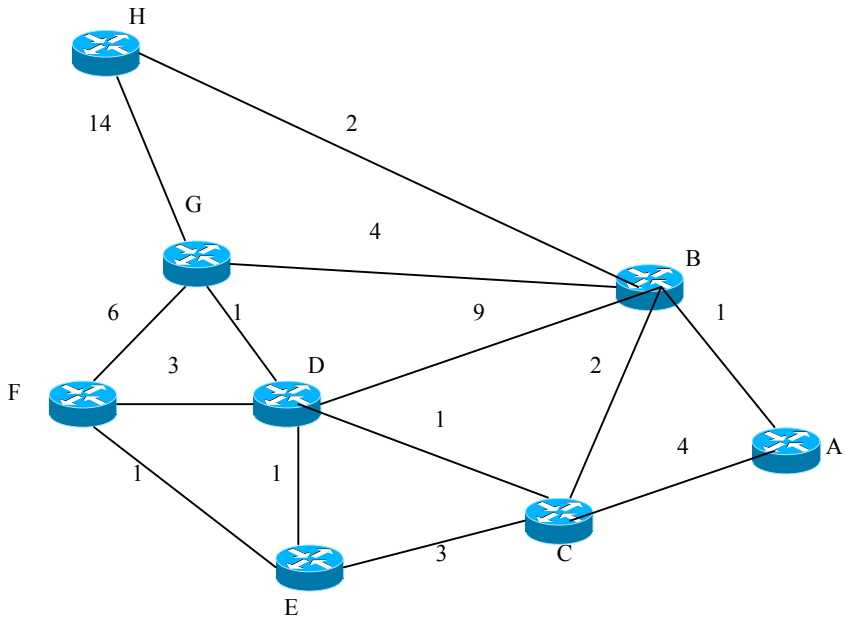
We replace the CRC bits (0 0 0) by calculated CRC 0 0 1

Shifted data (by 3) 0 1 0 0 0 0 1 1 0 0 1
|----|
CRC bits as calculated

Transmitted message = 0 1 0 0 0 0 1 1 0 0 1

(Simple method)
Sent message = D(x)*x^3 + CRC(x) = $x^9 + x^4 + x^3 + 1$

3. Using Dijkstra's algorithm, compute the shortest path from node E.



Solution: Dijkstra's at Node E

{M}	L(A)	Path	L(B)	Path	L(C)	Path	L(D)	Path
{E}	∞	----	∞	----	3	E-C	1	E-D
{E,D}	∞	----	10	E-D-B	2	E-D-C	1	E-D
{E,D,F}	∞	----	10	E-D-B	2	E-D-C	1	E-D
{E,D,F,C}	6	E-D-C-A	4	E-D-C-B	2	E-D-C	1	E-D
{E,D,F,C,G}	6	E-D-C-A	4	E-D-C-B	2	E-D-C	1	E-D
{E,D,F,C,,G,B}	5	E-D-C-B-A	4	E-D-C-B	2	E-D-C	1	E-D
{E,D,F,C,G,B,A}	5	E-D-C-B-A	4	E-D-C-B	2	E-D-C	1	E-D
{E,D,F,C,G,B,A,H}	5	E-D-C-B-A	4	E-D-C-B	2	E-D-C	1	E-D
{E,D,F,C,G,B,A,H}	5	E-D-C-B-A	4	E-D-C-B	2	E-D-C	1	E-D

L(F)	Path	L(G)	Path	L(H)	Path
1	E-F	∞	---	∞	---
1	E-F	2	E-D-G	∞	---
1	E-F	2	E-D-G	∞	---
1	E-F	2	E-D-G	∞	---
1	E-F	2	E-D-G	16	E-D-G-H
1	E-F	2	E-D-G	6	E-D-C-B-H
1	E-F	2	E-D-G	6	E-D-C-B-H
1	E-F	2	E-D-G	6	E-D-C-B-H
1	E-F	2	E-D-G	6	E-D-C-B-H